Research on Analysis of Multi-source Data Fusion Model in Smart Classroom

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Abstract

Smart Classroom, as a new learning environment, is a new direction in the development of education informatization and has been a hot research in the field of educational technology in recent years. Its wisdom goal is based on the large amounts of data that produced by learners study in the learning process. And for the Smart Classroom, the fusion analysis of the data in the learning process can provide some advice for learners and teachers. At present, there is little study on multi-source data fusion analysis. In view of this, this paper shows the research status of data fusion, and analyzes the Smart Classroom from the dimension of data sources and data fusion, then builds a process model of multi-source data fusion analysis, finally applies it into practice from the dimension of data fusion.

Keywords

Smart Classroom, Multi-source Data Fusion, Model

Introduction

Wisdom learning, as a new learning paradigm toward the 21 century, is the result of knowledge explosion, technological development and learning needs [1]. Smart Classroom, equipped with a large number of complex high-tech equipment and software system, provides learners with ideal learning conditions and space, and has been widely favored by learners and educators. Smart Classroom is a kind of new form of classroom, which is made up of a large amount of intelligent devices (wireless projector, interactive whiteboard, etc.), tools, technology, media, textbooks, teachers, students and the like [2], and it is a highly informational, interactive, good integrated teaching environment which allows the learners to interact with teaching activity platform, teachers, other learners, a variety of highly interactive teaching and learning facilities, intelligent environmental control system and so on. And in these processes, it may produce a lot of data all the time. These data reflect the information about learners' learning, and these informations are the key to fully grasp the present situation of learners' learning and are also the key to effective intervention. So we can learn about learners' learning by digging and analyzing these data.

Because of the particularity of its environment [3], the data about learners' learning obtained from Smart Classroom is fragmented and scattered in Smart Classroom, thus we can't directly find the relationship between learners' learning results with learning content, learning resources, teaching behavior, and learning environment. And, for now, because the traditional analysis method is single and limited, it makes these data produced in the process of learners' learning has not been fully digged and utilized. In other words, even if we have abundant learning process data, we can't maximally explore the "implied meaning", so we can't also come to the effective conclusion to guide teaching [4].

Multi-source data fusion, as a technology to deal with multiple sources of data, brings an opportunity to Smart Classroom for analysis of learning data. But, there is little study and research about learning data fusion analysis in domestic at present, and more focused on the descriptive research about theoretical exploration and the introduction of analysis method. So, this paper constructs a process model of multi-source data fusion analysis from the point of view of data fusion, aims at a deeper analysis of the learning data in the Smart Classroom, and to transform these data into information which provide services for teaching decision-making and optimization of learning.

Related Research

Data fusion is not a new concept, which was applied in military field as early as 1970s. With the complexity and intelligence of the industrial system, data fusion has made rapid development in recent decades, more and more educators begin to focus on the research of data fusion. Data fusion is a process of multi – stage and multi - level processing of data, mainly through automatic detection, association, estimation and fusion analysis to deal with a large amount of data from multiple information sources.

In recent years, our country also pays more and more attentions to the research of data fusion, the universities and research institutes are also carring out the relevant research work, and have achieved some results. So far, the research on data fusion in our country is focused on the data fusion of multi sensors. In terms of the definition of multi-sensor data fusion, different educators have different ideas, and the widely accepted definition can be summarized as [5]:'Make full use of the multi sensor data resources in different time and space, and use computer technology to observe the multi sensor data which is obtained by time series, then analysis, synthesis, dominate and utilize them under a certain criterion in order to obtain the consistency interpretation and description about the object to be measured. Finally implement the corresponding decision-making and estimation, so that the system can get more information than the components of it.' Different from single sensor data fusion, multi sensor data fusion not only can obtain more related information of the measured target and environment, but also can effectively make use of the collected data and maximum fusion analysis of these data, which not only enhances the reliability of data fusion system, but also greatly improves the system's credibility. And it can provide a guarantee for dealing with different sources, models, media, time of data. Compared with the classical data processing methods, multi sensor data fusion is not only involved in many classical methods, but also takes full advantage of some modern methods, which is more typical of neural network, expert system and least square method [6]; and because of the limitations of a single data fusion algorithm, we usually combine two or more than two data fusion algorithm with analysis of the data fusion. For the moment, though there is no complete system structure for multi-sensor data fusion, but the researchers have put forward some process and model on the basis of its practical application in different fields. Gong Yuanming[5] thought that data fusion followed data acquisition, data preprocessing, data fusion (feature extraction, data fusion calculation) and the result output. He You, Peng Yingning[7] considered that data fusion model mainly includes the function, structure and mathematical model, and the data fusion function model can be divided into detection level, tracking level, attribute level, situation level and threat level. This classification method is more advantageous to data fusion.

From the research on data fusion, it can be seen that data fusion has a great effect on analysis of multiple sources, heterogeneous, real-time data analysis, so we can apply the data fusion into Smart Classroom. So it can not only achieve the maximum collection, integration, analysis and visualization of classroom data, but also can optimize teaching based on the results of data fusion analysis in order to further promote learners' learning.

The Model of Multi-source Data Fusion Analysis in Smart Classroom

For the fusion of multi-source data analysis, data from multiple sources is the basis of the analysis. Similarly, the basis of data fusion analysis concludes interactive data generated in the Smart Classroom, video data captured by recording and playing system, and environment data recorded by intelligent environment control system. In the Smart Classroom, because of the different sources of data, making the data in the process of integration will have some conflicts. So, in the integration of multi-source data in the Smart Classroom, firstly, we can collect and summarize the multi-source data in the Smart Classroom, and then analyze the dimension of the data fusion, finally build a model of multi-source data fusion analysis process in the Smart Classroom.

The Data Sources in Smart Classroom

Smart Classroom, as a kind of learning environment that effectively promote the learners' individual learning, is not only equipped with a large number of high-tech equipment (such as recording and playing system, intelligent lighting, interactive whiteboard, wireless projector and various environmental monitoring sensors, etc.) and a variety of software service system (such as the teaching activity platform based on learning terminal), but also

makes full use of the advanced technology, such as the electronic whiteboard, wireless projection technology, intelligent space technology. Since the complexity of the classroom environment and equipment as well as the particularity of the teaching and learning activities, it makes the data produced by learners in the process of learning in the Smart Classroom in all aspects of different. In terms of the data produced in the Smart Classroom, the source and the specific data types are shown in Table 1.

TABLE 1 THE DATA SOURCES IN SMART CLASSROOM

Data sources	Data type
Recording and Playing System	Classroom video
System Database	User information, Course information
Teaching Activity Platform based on Learning Terminal	Login method, Log-in time
Intelligent Environment Control System	Browsing history
Other software	Interactive information, etc.

In the Smart Classroom, teaching activities and learning activities are based on learning support platform and a variety of highly interactive teaching and learning facilities, and the relevant facility will automatically record the data with the learner in the learning process. By analyzing these data, we can not only get a comprehensive description of the learning state of the learners, but also can use them to analyze the results to improve the teaching.

The Data Sources in Smart Classroom

From Table 1 can be seen: in the process of learning in the Smart Classroom of the learners, different devices will produce a wide variety of data, such as classroom video, learner's browsing, interactive information, etc. Because these data come from different devices, properties of the data collected is not the same, which makes the data in the process of integration will have some conflicts, such as how to fuse the data from different times, how to fuse all the data about a target, how to minimize the conflict of data fusion, data should be integrated in which specific points, etc. In view of these problems, we can consider from time and character two dimensions to the multi-source data fusion in Smart Classroom:

1) Time Dimension

In Smart Classroom, when capturing the behavior of participants by using different equipment acquisition, the acquisition of information in the time may not be synchronized. Therefore, we can align the data before they are analyzed. That is to say, firstly, we should seek a time point as a starting point, then use the relative starting point of time for each data calculation, finally synchronize all the data to the same time point, so that feature extraction and data fusion.

2) Character Dimension

Large amount of data may be generated through the interaction between teachers, students and devices in Smart Classroom in the process of teaching and learning. In order to achieve a specific analysis of the behavior of each participant, it needs to fuse and analyze all of its performance data. Therefore, in the analysis of the data in the Smart Classroom, the key is to obtain the data of each of the participants by feature matching, and then through the relevant technical means to analyze these data, in order to obtain a comprehensive description of the teaching status / learning status of each participant.

The Model of Multi-source Data Fusion Analysis in Smart Classroom

For the fusion analysis of the multi-source data in the Smart Classroom, the process mainly includes three parts: multi-source data acquisition, data fusion processing and result output. And the multi-source data is the object of data fusion; the coordination optimization and comprehensive processing is the core of data fusion [5]. The concrete process is shown in Fig. 1.
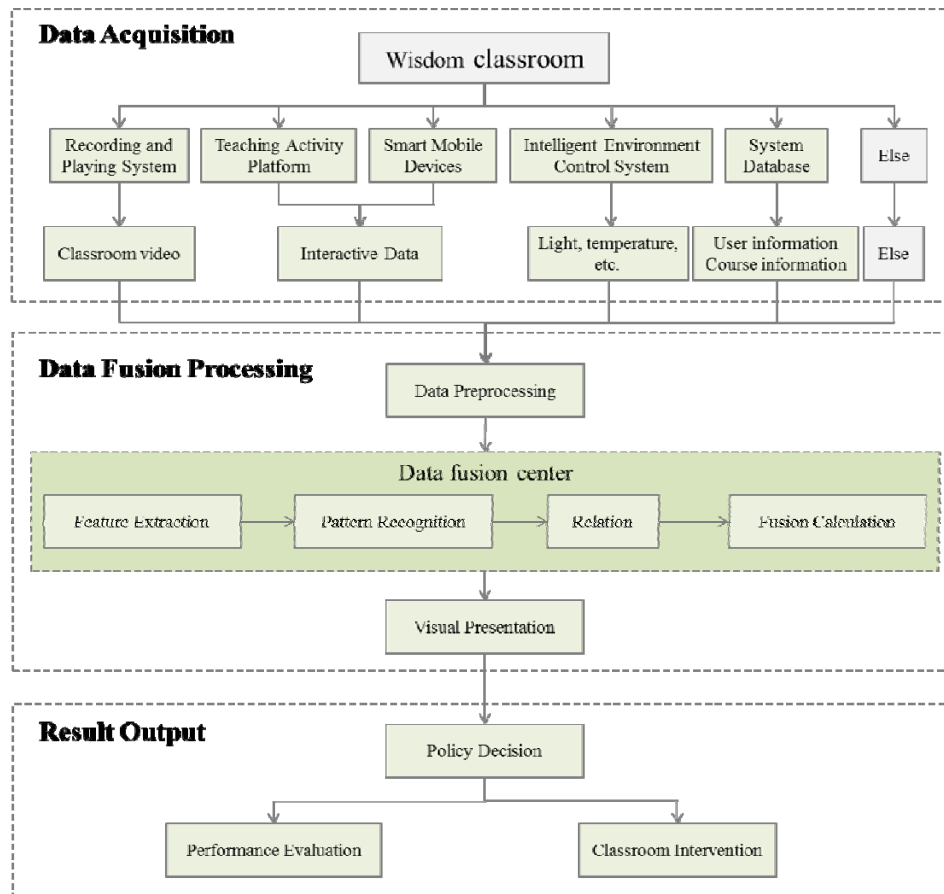
FIG. 1 ANALYSIS OF MULTI-SOURCE DATA FUSION AND ANALYSIS PROCESS MODEL IN SMART CLASSROOM

1) Multi-source Data Acquistion

In the Smart Classroom, based on the specific situation, the relevant data with the learner can be obtained by different devices and techniques. In data acquisition, because each device is independent of the collection and measurement, consistence can not be reached in the data collected, such as data from intelligent environment control system, teaching activity platform, intelligent learning equipment, classroom recording and playing system as well as the system database of the Smart Classroom .

2) Data Fusion Processing

The coordination optimization and comprehensive processing is the core of data fusion. Because the data collected in the form and description are different, so the data fusion center in order to coordinate optimization and comprehensive of these different sources of data, the data must first be preprocessed in order to convert themselves into the same form and description of the data before the relevant processing[8]. Then, analyzing the characteristics of these data after preprocessing and extracting the features of the target data, and identifying the various data grouping according to the characteristics of each type of features, and then forming a fusion target attribute measure, that is, the relation. Finally, using all sorts of fusion algorithm for each feature calculation of data fusion, and presenting the target data fusion analysis result to teaching workers in tables, text or other visual form.

3) Result Output

Result output, which is based on the visual results of the fusion analysis, evaluate the learning states and effects of the learners. Then form a decision, using the visual results to intervene the teaching and learning activities, improving the learning performance of the learners. In the output link, the teaching can not only evaluate the learning achievement and learning state of the learners according to the fusion analysis results, but also can predict the learning path in the Smart Classroom according to the relevant analysis results.

The Model of Multi-source Data Fusion Analysis in Smart Classroom

By the wireless network, we set up a wisdom learning environment based on PAD, as shown in Fig. 2. In this class, learners will learn with teachers and other learners by mobile terminal equipment, learning support platform and the surrounding environment along with communication or interaction occurs, it will produce many interaction data, such as classroom video, test information of learners, etc. Moreover, the system can automatically deal with the interactive information between teachers and students in each class, and the test information of the learners, and the feedback results are presented in the PAD of the teachers. Through the comprehensive analysis of the feedback information, teachers can provide guidance to the learners at any time, in order to facilitate the teaching and learning activities efficiently and smoothly.
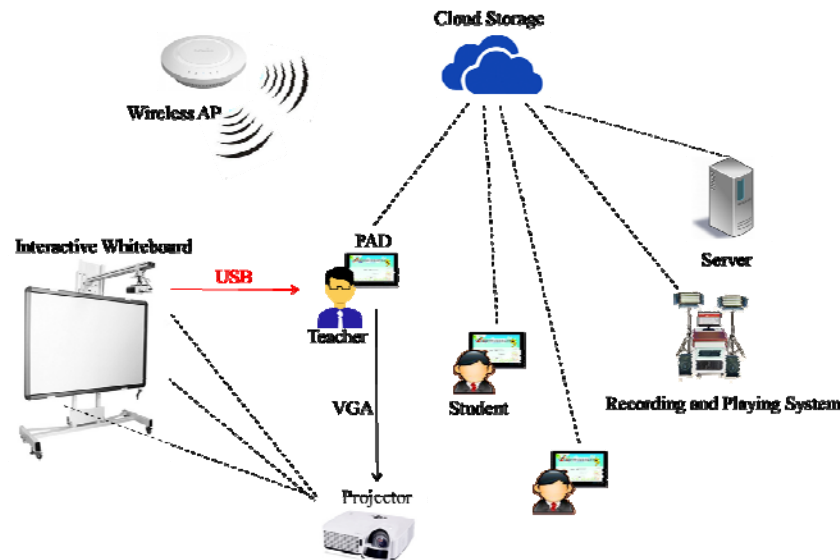
FIG. 2 SMART CLASSROOM MODEL BASED ON PAD

Of course, to achieve a more detailed analysis of the feedback results, teachers can play back to the corresponding period of classroom video, carefully observe and analyze the performance of learners and themselves according to the feedback results of the students to, then find a way to solve the problem, in order to change their teaching and provide better service for the learners.

Conclusions

With the rapid development of education informationization, the Smart Classroom has become a hot research in the field of education in recent years. In the Smart Classroom, learners in the process of their learning produce a huge amount of data, which reflects all the information of learners. Therefore, we can analyze the data generated in the classroom from the perspective of improving teaching and learning. Multi-source data fusion has been widely used in various fields because of its multiple data sources and multi-level, full range of sensing information. So, it can be applied into the data analysis of the Smart Classroom, in order to furthest dig the 'implied meaning' of the classroom data to draw valid conclusions to guide the teaching of intervention.

REFERENCES

[1]   He Bin. "Smart learning: connotation, evolution and trend---- the learner's perspective." *E-education research*, 2013, 11:24-33 + 52.

[2]   G. X. Zhong, X. Z. Zhang."Construction of a general intelligent learning environment model."*Computer science*, 2006, (1): 170-171.

[3]   Y. W. Tang, J. W. Pang, S. C. Zhong, W. Wang. "Method and case study on the construction of the Smart Classroom under the information technology environment."*China education Technology*, 2014,11:23-29+34.

[4]   Y. Y. Li, S. Q. Ma, R. H. Huang."Learning analysis technology: the design and optimization of service learning process."*Open education research*, 2012,05:18-24.

[5]   Y. M. Gong, D. Y. Xiao, J. J. Wang. "Multi sensor data fusion technology(on)."*Journal of metallurgical automation*, 2002,04:4-7.

[6]   M. G. Huang, S. C. Fan n, D. Z. Zheng, W. W. Xing. "Research progress of multi sensor data fusion technology."*Journal of sensor and micro system*, 2010,03:5-8+12.

[7]   Y. He, Y. N. Peng, D. Lu. "The review of multi sensor data fusion." *Journal of Tsinghua University (Natural science edition)*, 1996,09:14-20

[8]   Z. J. Zhu, T. Huang, X. X. Liu, Y.Lv. "The research status and development direction of multi sensor data fusion technology."*Journal of Ship Electronic Engineering*, 2009,02:13-16.